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Change Detection of Land Use Changes in Naein City of Using Satellite Data of Landsat

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Abstract: Urban land use change may influence natural phenomena and ecological processes. Decreasing of cultivated land area in Chengdu is one of the critical problems in recent years. The objective of this study is to detect land use changes between 1990 to 2002 using satellite images of Landsat TM/ETM+. Different existing applicability per year was obtained from the extracted photos and after using LMM model and GIS software for each type of land use. Different classification methods were analyzed in this research and 6 different applicability were extracted for each year. The area of residential places according to this no search has increased from 180.9 to 382.95 hectares in 12 years and about 35% of the total area has under gone changes in the same period, indicating the intensity of human destructions in this short period. LMM model is a simple, but effective method for analyzing applicability changes in district in different periods.

Key words: Revealing changes · LMM model · Land applicability · Remote analysis and Fcc

INTRODUCTION

Revealing the changes include the application of the set of multi lateral data to define the regions that the applicability and the land cover have had variations in different imaging times. The variations could be due to covering changes in short term, including snow, flood and change in applicability such as urban development and transformation of agricultural lands to residential and industrial applications [1]. Methodology and the algorithm for transformation and discovering the variations due to the effects regarding the revelation are important and principle actions, since the selected method for restoration and discovering the changes is obtained via the satellite pictures and their interpretations and analysis have therefore great and considerable effects [2]. The most important restoring methods for the changes include: 1) subtraction of pictures, 2) Division of pictures, 3) Analysis of main components, 4) Using the fuzzy logic, 5) Comparison post classification and 6) Timing spectral classifications.

The use of geographic information systems (GIS) and remote control data could be evaluated in situations with rapid prospective changes in respected time, due to processes such as erosion, deforestation, development of urban regions, etc. and analysis of the variation causes in finding the residing pattern variation and the predictions due to the changes and the relevant simulations could hence be effective. Many researchers have dealt with this issue, by using different methods of processing pictures and analyzing relevant places, in geographic information system to reveal the changes in applicability of lands in different parts of the world [2-4].

In a research in Katmandu valley in Nepal, Rajesh Bahador [5] analyzed the conditions of the applicability of lands changes.

By using satellite pictures regarding 1989, 1999 and 2005, he stated that changes in agricultural lands were considerable in comparison to other applications of the lands. Also, in 1989 the residential areas were established in 23% of the total region, while this amount increased by 17% in 2005 and the agricultural areas during that year were reduced from 36% to 22%. Feyzizadeh and Haji mir Rahimi [6] used the TM pictures of landsat and HDR of spot satellite and studied the changes of green areas of the city of Tabriz by the objective classification method.

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According to this research, it was found that more than 46% of the green area in Tabriz has been destroyed in a 16 year period. Adel *et al*. [7] obtained the applicability change of the lands in northwest coasts of Egypt, by using the supervised classification method, via the highest probability and performing post classification, by using the measuring pictures of landsat, from 1978 to 2001.

Zeaiean Firouzabadi [2] presented the map of changed and unchanged regions, as well as their different types and grades, by using the date from the pictures from 1993-94 by IRS satellite and by applying the Fuzzy logic and PCD in the city of Madras in India and its coastal regions. Lashkari [8] used the probability index and Fuzzy logic and multiple pictures in preparing the topography for the changes in applicability of the lands in the city of Mashhad and concluded that the multiple pictures show the changes in the considered area that could be observed by using the analytical method for the principle components (PCA) and the region Fuzzy logic, as well as the grade of the pixels. Koohkan [9] extracted the changes of applicability of lands in Mashhad within 1987-98, by the use of analyzing the principle components, subtraction and classification of the pictures and also by applying the Fuzzy logic. Due increasing changes, especially by human activities, analyzing the changes, evaluation of the trends and environmental effects for future planning and management of resources are essential, such that revealing the changes including the application of the set of multiple data is used for defining the regions having changes of applications in different imaging dates. The changes may be due to covering changes in short-term basis, including snow, flood, changes of applicability of lands such as urban development and transformation of natural lands for agricultural purposes, etc. The aim of this research is analyzing the potentials of LMM in analyzing the changes in Naein region within 1990 to 2000.

MATERIALS AND METHODS

Study Area: The city of Naein is situated in Esfahan province and its center is the town of Naein. At the moment, this city has two parts: central part and Anarak and 3 urban sections including Naein, Bafran and Anarak and 5 villages. With the area of 35927.8 km^2, this city is the largest city of the province. 0.0021% (8383 Ha) of the land in this city is allocated to agriculture and 27.8% is allocated to flowing sand, 48.5% is pasture and 6.9% is allocated for mountains and residential places [10]. The city is considered as having a desert climate, with two weather conditions, 1) dry and warm for the region adjacent to the desert, 2) moderate mountainous climate for the region southwest of the city. Average rain is 97mm for 5 year period and the difference for hot and cold temperatures is almost 30ú c for the two climatic regions. Water, in this desert city has been the most important and vital element for survival during different historical eras and certainly, water reservoirs are the main source of supplying water in hot seasons and more than 50 water reservoirs are to be observed in this city. 89% of which are utilized by electric pumps. Subterranean canals are considered important in the city of Naein, such that about 720 canals have been made in the whole area of the city. Among the most important and oldest buildings of the city, Narin Qaleh or Naranj Qaleh could be named that with regards to the type of materials and used stones, could be related to Parthian or Sassanid era and could probably be a Zoroastrain temple [10].

Methodology: TM Satellite image of Sep. 1990 and ETM image regarding May 2002 were used for analyzing the changes and relevant trends in the region and geometric and radiometric modifications were done on both types of images. Another modification done at this stage was transformation of DN values to reflective values of the images. By consideration of specific complications by the images, using the objects reflective values is preferable to using "DN" values, since the errors including atmospheric errors, solar altitude, the distance from sun to earth and the biases are eliminated by performing the transformation process of DN to reflective values [11]. Conversion DN to reflective value includes two stages, 1) Conversion to at-sensor spectral radiance and 2) Conversion to TOA reflectance. To do the required stages, the instruction file for the images, formulae and proposed coefficients of Chander *et al*. [11] were used. To conversion the "DN" of landsat images to absolute radiation value, the following formula is used.

$$L_\lambda = \left(\frac{LMAX_\lambda - LMIN_\lambda}{Qcal\max - Qcal\min}\right)(Qcal - Qcal\min) + LMIN_\lambda \quad (1)$$

Where

L_λ	=	Spectral radiance at the sensor's aperture [W/(m2 sr µm)].
Qcal	=	Quantized calibrated pixel value [DN].
Qcal max	=	Maximum quantized calibrated pixel value corresponding to LMAXλ [DN].

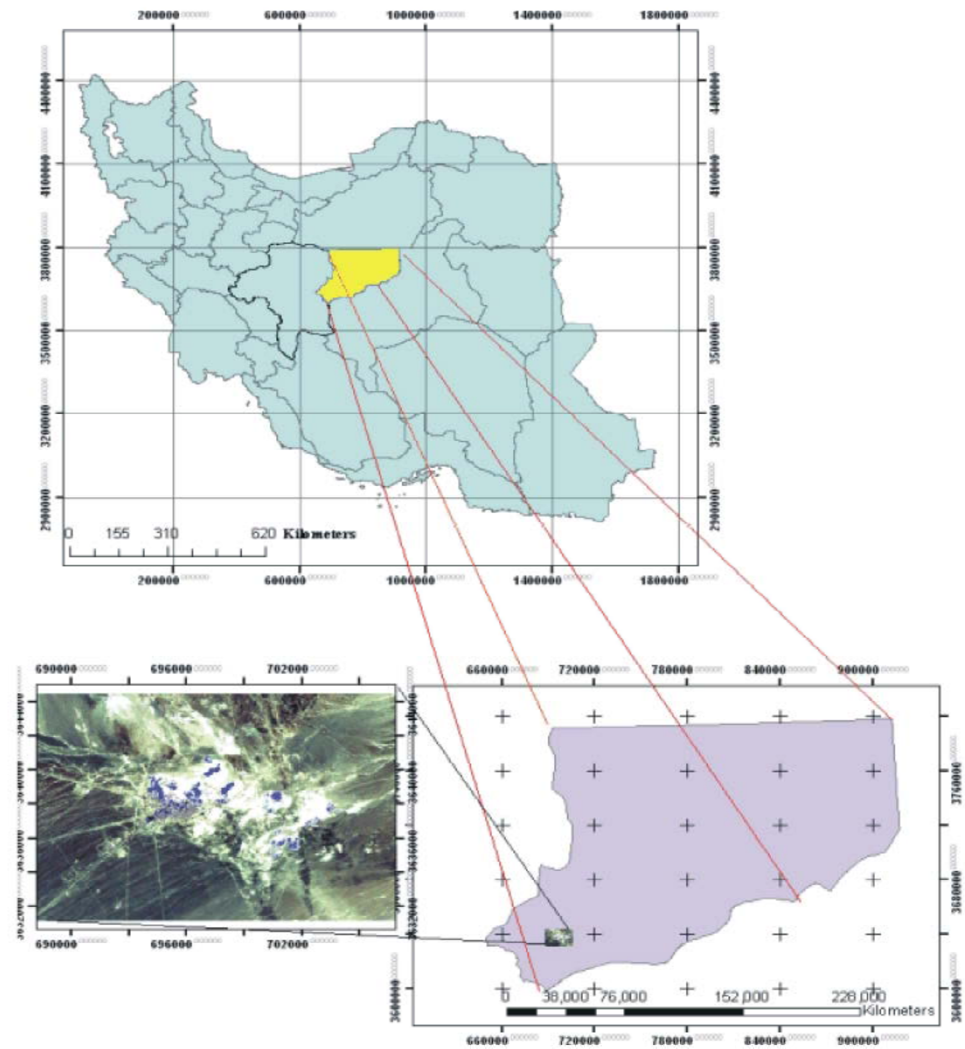

Fig. 1: Location of study area

Qcal min = Minimum quantized calibrated pixel value corresponding to LMINλ [DN].

$LMAX_{\lambda}$ = Spectral at-sensor radiance that is scaled to Qcalmax [W/(m^2 sr μm)].

$LMIN_{\lambda}$ = Spectral at-sensor radiance that is scaled to Qcalmin [W/(m^2 sr μm)].

To classify the images, the above procedures are first done and the basis of classification was according to the reflective values resulted from the previous stage. At the beginning by using non-supervised classification we dealt with analysis and evaluation of a no. of existing classifications in the studying region. Hence, the classification was done with regards to Isodata algorithm of 2002 image in non-supervised condition. Due to enormous in homogeneity and sudden changes in the region, using the above algorithms was not quite useful and therefore the images were classified by the use of supervised classification methods. First the training points were accurately selected for supervised classification and introduced to the system and then the max. Similarity method was used for classifying the pictures, since by the use of average and practicing data covariance matrix, this method provides more precise results than other methods such as the classification of the least distance and parallel planes classification. 6 land applicability classifications were considered for each pair of images, with regards to the classification and topographic graphs.

As stated in the last classification stage, each image was parted in to 6 classifications. At this stage, to define the transformation of different lands usage to each other, the codes given in the last stage to the classifications were used. Hence by "LMM2" model, the rate of changes was calculated [10, 12].

$$LMM = CT_1 \times 10 + CT_2 \text{ ....} \qquad (2)$$

Where

LMM = Land use multiplication matrix,
CT_1 = Classified image of the first date,
CT_2 = Classified image of the 2^{nd} image.

RESULTS

The area of each layer is calculated, which is observed in Table (1) and most of the area in the region is covered in 1990, by pastures, which is about 77.7 percent and this type of land was about 57.01% in 2002 and the lowest area was for water farming in 1990, by 1.17% and in 2002, the gardens constituted 1.07 percent.

As indicated before, at the last stage of classification, each image was divided in to 6 classifications. To define the transformation of different land usage to each other, the codes given to the classifications in the last stage were used. A matrix (6×6) was formed; in which each entry indicate the change and transformation of each land use. For instance, the entry (16) [residential + l0* agricultural] indicated transforming agricultural land to residential and the entry (45) [4*l0+5] showed transforming of pasture to bare land. Moreover, the numbers and unchanged entries of this matrix, i.e. the ones having no change in usage every two years included:

11 (agricultural land to agricultural land, 22 (dry farming to dry farming) 33 (garden to garden), 44 (rangeland to rangeland), 55 (bare land to bare land) and 66 (residential to residential) were among the unchanged lands in the classification (Fig. 2). Table (2) shows the rate of transformations to other applications in the period (1990-2002). Hence, the case with most of the changes is about changing from pasture to bare lands. Accordingly,

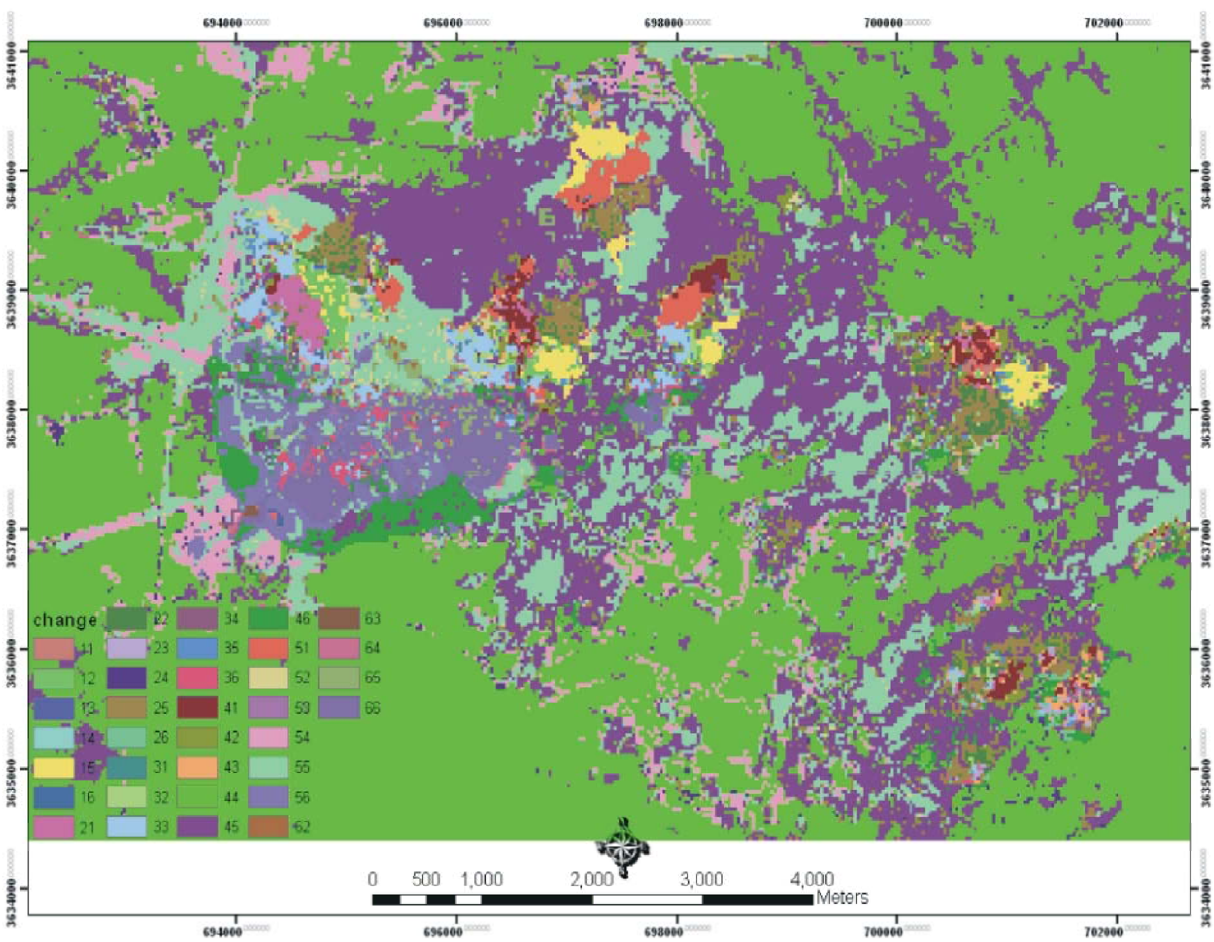

Fig. 2: Change detection of land use to each other using LMM model

Table 1: Regarding the area for different land uses

No	Applicability	Area in 1990 (hectare)	Area (%)	Area in 2002 (hectare)	Area (%)
1	Water farming lands	97.29	1.17	122.13	1.47
2	Dry land farming	199.89	2.40	228.78	2.75
3	Orchard	113.94	1.37	89.37	1.07
4	Rangeland	6478.29	77.78	4748.76	57.01
5	Bare land	1258.74	15.11	2757.06	33.10
6	Residential	180.90	2.17	382.95	4.60
Total		8329.05	100.00	8329.05	100.00

Table 2: Rate of change in the land uses to other applications of lands in the studying period (1990-2002)

Area (Ha)	Case	Area (Ha)	Case	Area (Ha)	Case
47.7456	51	3.3712	31	32.0656	12
35.672	52	19.1296	32	3.6064	13
3.9984	53	1.4896	34	0.1568	14
263.5808	54	18.7376	35	53.2336	15
93.3744	56	22.8928	36	0.6272	16
3.4496	62	42.4928	41	22.2656	21
2.9008	63	120.7360	42	11.9952	23
11.2896	64	18.5024	43	44.7664	24
41.6304	65	1744.2430	45	126.6160	25
5406.7	No changes	126.5376	46	14.4256	26

about 35.15 % of the region has undergone changes (Table 2). The rate of changes is confirmed by analysis of the verification of the prepared graphs in two different dates.

DISCUSSION AND CONCLUSION

Expansion of cities and urban development are among the problems regarding human civilization. Extended destruction of agricultural lands, forests, rangeland and transforming them to residential and bare lands is not only considered for Iran, but it‘s intensity is quite tangible. Regarding by and due to the achievements of this research, the area of residential region has increased from 180.9 to 382.95 hectares in 12 years. Undoubtedly, without benefitting new technologies, environmental studies, accurate estimation and economic studies of such changes is impossible. In this case, remote controlling and geographic information system have great role and it is recommended that more research is done in this regard. Time is a very important factor in revealing the changes that is usually ignored. This factor is effective in atmospheric and radiometric modifications, selection of educating samples and the considered complication, in classification stage, as well as in revealing and evaluation of the results.

LMM model is a simplified method and effective one in analyzing the changes of land use at different periods [9] and as a result, we face lots of data and information. Hence, it is better that before using the model, the relevant images be classified according to the considered subject(s), in order, from one hand, to have speeded up the operation and on the other hand, not to be forced to eliminate the extra information that we come across. If we regard the reduction of rangelands and gardens into two natural factors (drought, etc.) and human interventions (including expansion of residential centers, roads and bare lands), we will notice that the effect of human factor has been more than natural factors in reducing pasture and garden areas. Akbari [13] states the transformation of rangelands to agricultural, wrong agricultural patterns, over grazing and improper economic conductions have been the factors of development of bare lands and deserts. Also Khresat and Mohammad [14] have in their research for Jordan and moradi *et al*. [15] in the research for Ardakan region (Iran) indicated the main factor in lands destruction and development of bare lands to be due to uncontrolled development of urbanism and transformation of rangelands, gardens and agricultural lands. Regarding the changes in the region, about 35% of the total area in the studying period, has undergone changes that indicates the intensity of human destruction of the lands in this short period. Economic and social problems of different regions and increasing population in rural districts and lack of required investment in other parts, unemployment and instructing stockbreeders to be employed in other areas have caused increasing the no. of livestock relative to pastures, resulting in destruction of pastures and increasing soil washout in the region, following increasing bare and uncovered lands [16]. Like other natural fields of the country, uncontrolled grazing, expansion of mining activities usually simultaneous with lack of observing environmental concerns, together with development of water farming in pastures having no farming potential have been among the threats for natural ecosystem in the region that should be considered for their modifications. Moreover, more elaboration of organizations, people's coordination, informing, training and proper planning in preservation of environment and natural resources are quite necessary, together with stable research and developments.

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